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(54) **Hydrodynamic suction catheter**  
Hydrodynamischer Saugkatheter  
Cathéter d'aspiration hydrodynamique

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**EP-A- 0 442 579** **WO-A-92/15343**  
**US-A- 2 568 566** **US-A- 4 790 818**

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## Description

[0001] The invention relates to a hydrodynamic drainage catheter comprising a basic body with a distal and a proximal end in which a pressure channel and a discharge channel have been formed. At the distal end the discharge channel is connected to a suction opening and the pressure channel to a jet nozzle which empties into the discharge channel and is directed towards the proximal end of the catheter.

[0002] Such a catheter is known from the European patent application 0 442 579 upon which the preamble of claim 1 is based, wherein the inlet opening has been formed in a side wall of the discharge channel and the jet nozzle ends adjacent to the distal end of this opening and is directed closely along it. Together with the inlet opening, the jet nozzle forms an ejector. When liquid under pressure is supplied to the jet nozzle via the pressure channel, the liquid jet flowing from the jet nozzle and directed along the opening will generate a suction this opening. An important application of such a catheter is therefore a thrombectomy-catheter for the removal of blood clots or thrombi from the vascular system of a patient.

[0003] When such catheters are very long and thin, removal of the sucked up material through and from the discharge channel can become difficult. The flow resistance in the discharge channel becomes too great in order to maintain sufficient flow in this channel with the aid of the liquid jet from the jet nozzle.

[0004] The object of the invention is to improve a hydrodynamic suction catheter of the type described in the preamble in such a way that also at a greater length and smaller diameter its function will remain reliable.

[0005] With the catheter according to the invention this is achieved with the measures as characterised in claim 1. Herewith it is possible to utilize the liquid under pressure already present to generate additional suction with the aid of the liquid jet pump. Because of the extra suction the sucked up material can still be removed in a reliable way through a discharge channel of the catheter with a greater length and a smaller diameter. The advantage of the known catheter that no suction sources dependent on other sources of energy need to be used, remains unchanged with the catheter according to the invention.

[0006] An advantageous development of the catheter according to the invention is characterised in claim 2. Connecting the catheter according to the invention becomes consequently very easy.

[0007] The measure as set out in claim 3 achieves that the catheter forms together with the liquid jet pump one whole; hence a compact liquid jet pump can be made so that the embodiment of this catheter is easy to handle. The Y-piece is preferably made by injection moulding. The liquid jet pump and the connecting channels can in that case be defined by an insert consisting of two parts joined by for instance ultrasonic welding to

make up a whole.

[0008] In order not to affect the working of the jet nozzle adversely the measure as set out in claim 5 is preferably applied.

[0009] The invention will be explained in greater detail in the following description with reference to the attached drawings.

[0010] Fig. 1 is a schematic view of a catheter according to the invention in the position of use.

[0011] Fig. 2 represents a partly broken away view of an embodiment of a catheter according to the invention.

[0012] Fig. 3 represents an enlarged, partly broken away view of the distal end of a catheter according to the invention.

[0013] Fig. 4 represents a partly cross-sectional view of another embodiment of a catheter.

[0014] Fig. 5 represents the Y-piece of the catheter of fig. 4 enlarged and in a partly broken away perspective view.

[0015] A preferred embodiment of the catheter 1 as shown in Fig. 1 comprises a tube-like basic body 2 with a distal end 8 in which a suction opening 9 has been formed. Close to the other, proximal end the basic body 2 is connected to a Y-piece 3 which is shown in greater detail in Fig. 4 and 5 and which will be explained further with reference to these drawings.

[0016] Connected with the Y-piece 3 is a first tube 4 to which a source of liquid under pressure, in this case a pump 6 drawing from a reservoir 12, is connected. Furthermore a discharge tube 5 is connected to the Y-piece 3 leading to a discharge reservoir 7.

[0017] The pressure line 4 is, inside the Y-piece 3, connected with a pressure channel in the basic body 2 and also with a pressure inlet of a liquid jet pump incorporated in the Y-piece 3.

[0018] The working of the catheter as shown in Fig. 1 will be explained further with reference to Fig. 2 and 3. In Fig. 2 it can be seen that the basic body 16 of the illustrated catheter 15 comprises a pressure channel 17 and a discharge channel 18. This basic body 16 has been incorporated in a distribution piece 19 in which the two channels 17, 18 of the basic body are connected to separate in- and outlets respectively. The inlet leading to pressure channel 17 is connected to a tube 20 delivering the liquid under pressure in for example the way shown in Fig. 1 with the aid of a pump.

[0019] The liquid under pressure flows via pressure channel 17 in the basic body 16 to the distal end 8 of the catheter as shown in Fig. 3.

[0020] A U-shaped metal tube 29 is, as Fig. 3 shows, positioned with its legs 30, 31 in the pressure channel 17 and the discharge channel 18 respectively. The U-tube is fixed in position by hardened filling material 32. The end of the catheter is finished with a nose-piece 35 made of a soft plastic material. The end portion has been ground in the usual manner in order to ensure a smooth surface.

**[0021]** The leg 31 of the U-shaped metal tube extending into the discharge channel is provided with a tapered portion 34, so that a jet nozzle 36 is formed at the end of the leg 31. This jet nozzle 36 directs the fluid which is delivered through the pressure channel 17 in a carefully controlled manner along the inside of the inlet opening 9, so that an ejector action is obtained in a reliable and efficient way. By means of this ejector action material outside the catheter in the vicinity of the opening 9 is sucked through this opening 9 and is carried along in the discharge channel 18 towards the proximal end. As is shown in Fig. 2 a tube 25 connects to the discharge channel 18 inside the distribution piece 19. This tube 25 is connected to the suction inlet 24 of a liquid jet pump 21. The liquid jet pump 21 also comprises a pressure inlet to which a pressure tube 22 is connected which, inside the liquid jet pump 21, debouches into a jet nozzle 23. Liquid under pressure delivered through the tube 22 is emitted in the form of a jet at a relatively high velocity through the jet nozzle 23, thus creating suction at the location of suction inlet 24. The removal of material sucked up through inlet opening 9 via the discharge channel 18 and the tube 25 is supported by means of this suction. Together with the liquid delivered through the pressure line 22 the sucked up material is removed through the tube 26 to a discharge reservoir such as the discharge reservoir 7 of Fig. 1.

**[0022]** As said before, in the preferred embodiment of Fig. 1 the liquid jet pump is incorporated in the Y-piece 3.

**[0023]** In this embodiment the pressure connection of the pressure channel of the catheter has furthermore been combined with the pressure inlet of the liquid jet pump to form one pressure line 4. In the Y-piece 3 two connecting channels 40 and 41, also formed in the Y-piece 3, branch off from the pressure line 4. The connecting channel 40 leads to the pressure channel of the basic body of the catheter and the connecting channel 41 leads to the nozzle 42 of the liquid jet pump. A third connecting channel 43 leads from the discharge channel of the body of the catheter 2 to the suction inlet of the pump 45. The discharge channel 44 of the pump 45 is connected to the discharge tube 5 of the Y-piece 3.

**[0024]** As appears clearly from the figures the catheter according to the invention with the combined pressure connection for the pressure channel and pressure inlet for the liquid jet pump, is just as easy to use as the previously known hydrodynamic suction catheter. Compared with the known catheter there are no additional connections while the catheter according to the invention can be manufactured with a greater length and a smaller diameter.

**[0025]** The Y-piece 3 can for instance be manufactured by injection moulding whereby the liquid jet pump is defined in the insert in the usual or obvious manner. This insert itself can be made in two halves by injection moulding, which halves will be joined afterwards by for instance ultrasonic welding to form one unit. The basic

body of the catheter and the connecting tubes can be fixed in the Y-piece 3 by welding, glueing or by injection moulding of the Y-piece.

**[0026]** As the catheter according to the invention can create the suction required for the removal of unwanted material in two places, namely at the inlet opening at the distal end by ejector action and in the liquid jet pump there is considerable freedom of design especially where the distal end of the catheter is concerned.

**[0027]** When an embodiment, chosen for particular reasons, would result in a somewhat diminished ejector action, this reduced ejector action could be compensated for by manufacturing the liquid jet pump in such a way that it creates a stronger suction. It is even possible that the liquid jet pump is the only element creating suction and that the jet nozzle at the distal end serves for instance only as a means to pulverize the material to be sucked away.

### Claims

1. Catheter comprising a tube-like basic body (16) with a distal and a proximal end, with therein a pressure channel (17) and a discharge channel (18) wherein at the distal end the discharge channel is connected with an inlet opening (9) and the pressure channel with a jet nozzle (36) which empties into the discharge channel and is directed towards the proximal end of the catheter and wherein close to the proximal end the pressure channel has a pressure connection (19) for the supply of liquid under pressure characterized in that the discharge channel is connected to the suction inlet of a liquid jet pump (21) which furthermore comprises a pressure inlet for the supply of liquid under pressure.
2. Catheter as claimed in claim 1, wherein the pressure line of the pressure channel and the pressure inlet of the liquid jet pump are combined to form one pressure line (4).
3. Catheter as claimed in claim 2, wherein the liquid jet pump has been formed in a Y-piece (3) connected to the basic body of the catheter comprising the pressure line for liquid under pressure, a discharge tube and internal connecting channels (40, 41).
4. Catheter as claimed in claim 3, wherein the Y-piece has been manufactured by injection moulding.
5. Catheter as claimed in any of the preceding claims wherein the flow resistance for liquid under pressure in the liquid jet pump is greater than in the entire pressure channel and nozzle.

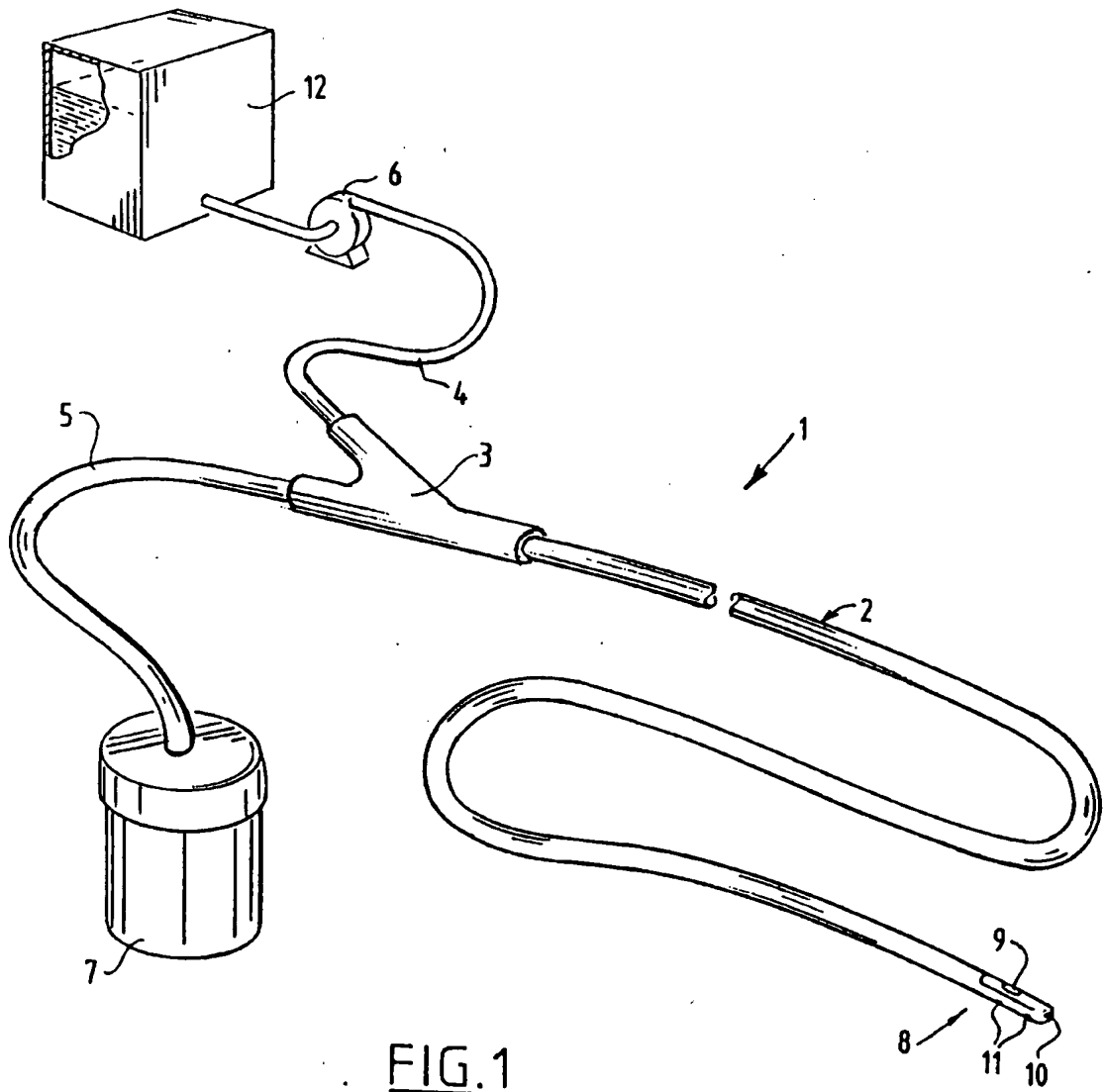
## Patentansprüche

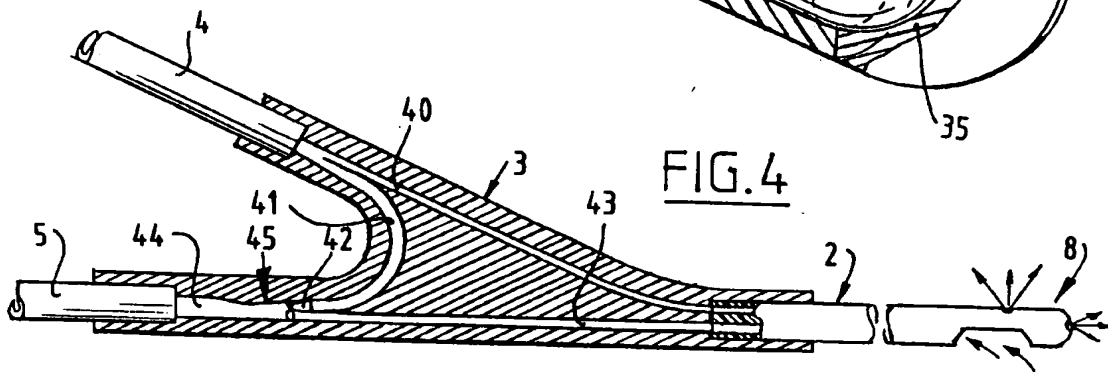
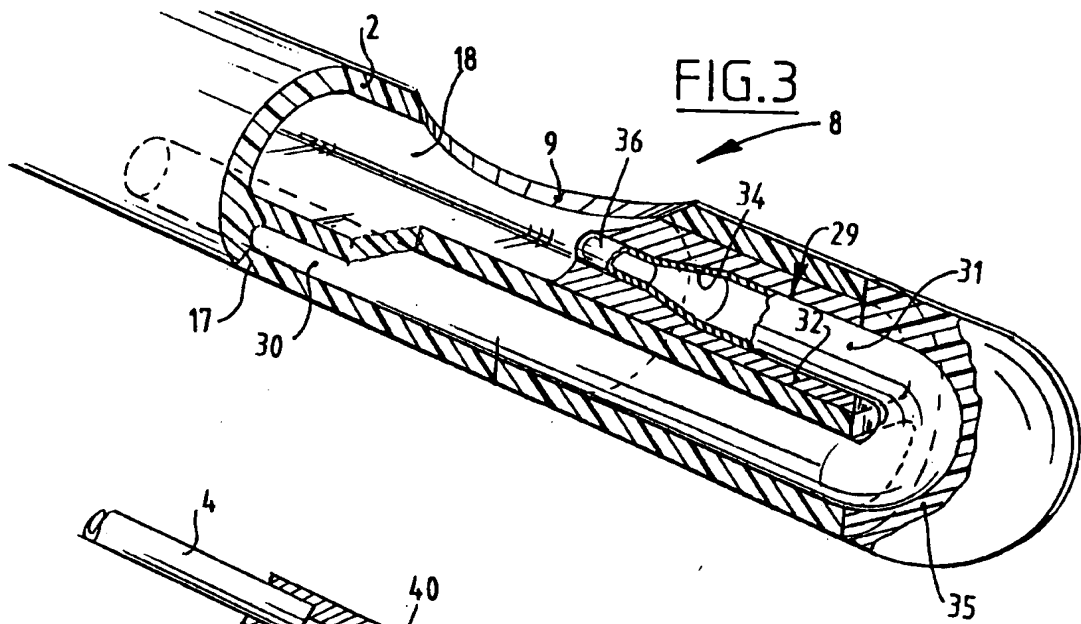
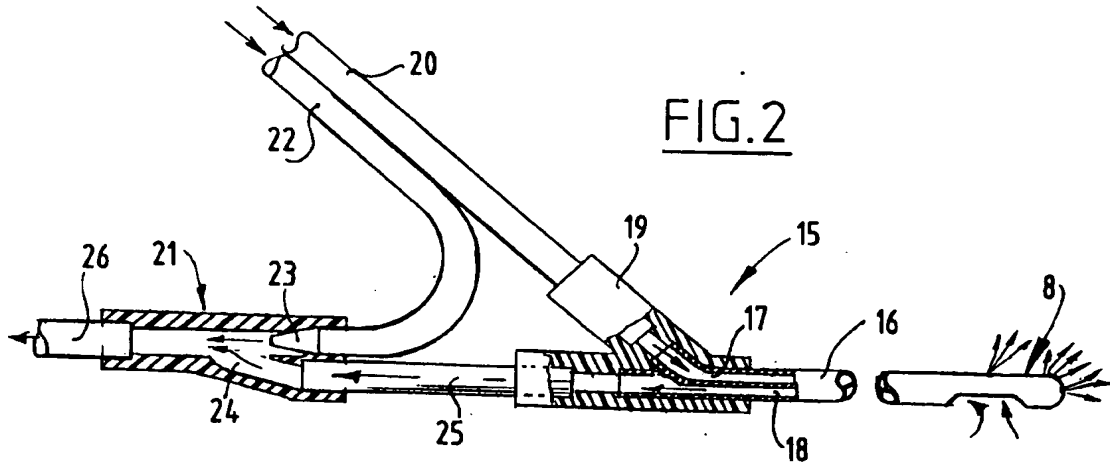
1. Katheter mit  
einem röhrenartigen Basiskörper (16) mit einem  
entfernten und einem nahen Ende mit einem  
Druckkanal (17) und einem Auslaßkanal (18) darin,  
worin an dem entfernten Ende der Auslaßkanal mit  
einer Einlaßöffnung (9) und der Druckkanal mit  
einer Strahldüse (36) verbunden sind, die sich in  
den Auslaßkanal leert und zu dem nahen Ende des  
Katheters gerichtet ist, und worin der Druckkanal  
nahe dem nahen Ende eine Druckverbindung (19)  
für die Lieferung von Flüssigkeit unter Druck auf-  
weist,  
dadurch gekennzeichnet,  
daß der Auslaßkanal mit dem Ansaugelaß einer  
Flüssigkeitsstrahlpumpe (21) verbunden ist, die  
weiterhin einen Druckeinlaß für die Lieferung von  
Flüssigkeit unter Druck aufweist. 5
2. Katheter nach Anspruch 1, bei dem die Drucklei-  
tung des Druckkanales und der Druckeinlaß der  
Flüssigkeitsstrahlpumpe zum Bilden einer Drucklei-  
tung (4) kombiniert sind. 10
3. Katheter nach Anspruch 2, bei dem die Flüssig-  
keitsstrahlpumpe in Form eines Y-Stückes (3) ist,  
die mit dem Basiskörper des Katheters verbunden  
ist, die Druckleitung für die Flüssigkeit unter Druck,  
eine Auslaßröhre und innere Verbindungskanäle  
(40, 41) aufweist. 15
4. Katheter nach Anspruch 3, bei dem das Y-Stück  
durch Spritzgießen hergestellt worden ist. 20
5. Katheter nach einem der vorhergehenden Ansprü-  
che, bei dem der Flußwiderstand für Flüssigkeit  
unter Druck in der Flüssigkeitsstrahlpumpe größer  
als in dem gesamten Druckkanal und -düse ist. 25

## Revendications

1. Cathéter comportant un corps de base analogue à  
un tube (16) ayant une extrémité distale et une  
extrémité proximale, ayant à l'intérieur un canal de  
pression (17) et un canal d'évacuation (18), dans  
lequel à l'extrémité distale le canal d'évacuation est  
relié à une ouverture d'entrée (9) et le canal de  
pression est relié à une buse d'éjection (36) qui se  
vide dans le canal d'évacuation et est dirigée vers  
l'extrémité proximale du cathéter, et dans lequel, à  
proximité de l'extrémité proximale, le canal de pres-  
sion a une liaison de pression (19) pour l'achemine-  
ment de liquide sous-pression, caractérisé en ce  
que le canal d'évacuation est relié à l'entrée d'aspi-  
ration d'une pompe à jet de liquide (21) qui com-  
porte de plus une entrée de pression pour  
l'acheminement de liquide sous-pression. 40

2. Cathéter selon la revendication 1, dans lequel la  
ligne de pression du canal de pression et l'entrée  
de pression de la pompe à jet de liquide sont com-  
binées pour former une ligne de pression (4).
3. Cathéter selon la revendication 2, dans lequel la  
pompe à jet de liquide est formée dans une pièce  
en forme de Y (3) reliée au corps de base du cathé-  
ter comportant la ligne de pression pour du liquide  
sous-pression, un tube d'évacuation et des canaux  
de liaison internes (40, 41).
4. Cathéter selon la revendication 3, dans lequel la  
pièce en forme de Y est fabriquée par moulage par  
injection.
5. Cathéter selon l'une quelconque des revendica-  
tions précédentes, dans lequel la résistance à  
l'écoulement du liquide sous-pression dans la  
pompe à jet de liquide est plus importante que dans  
le canal de pression entier et la buse.





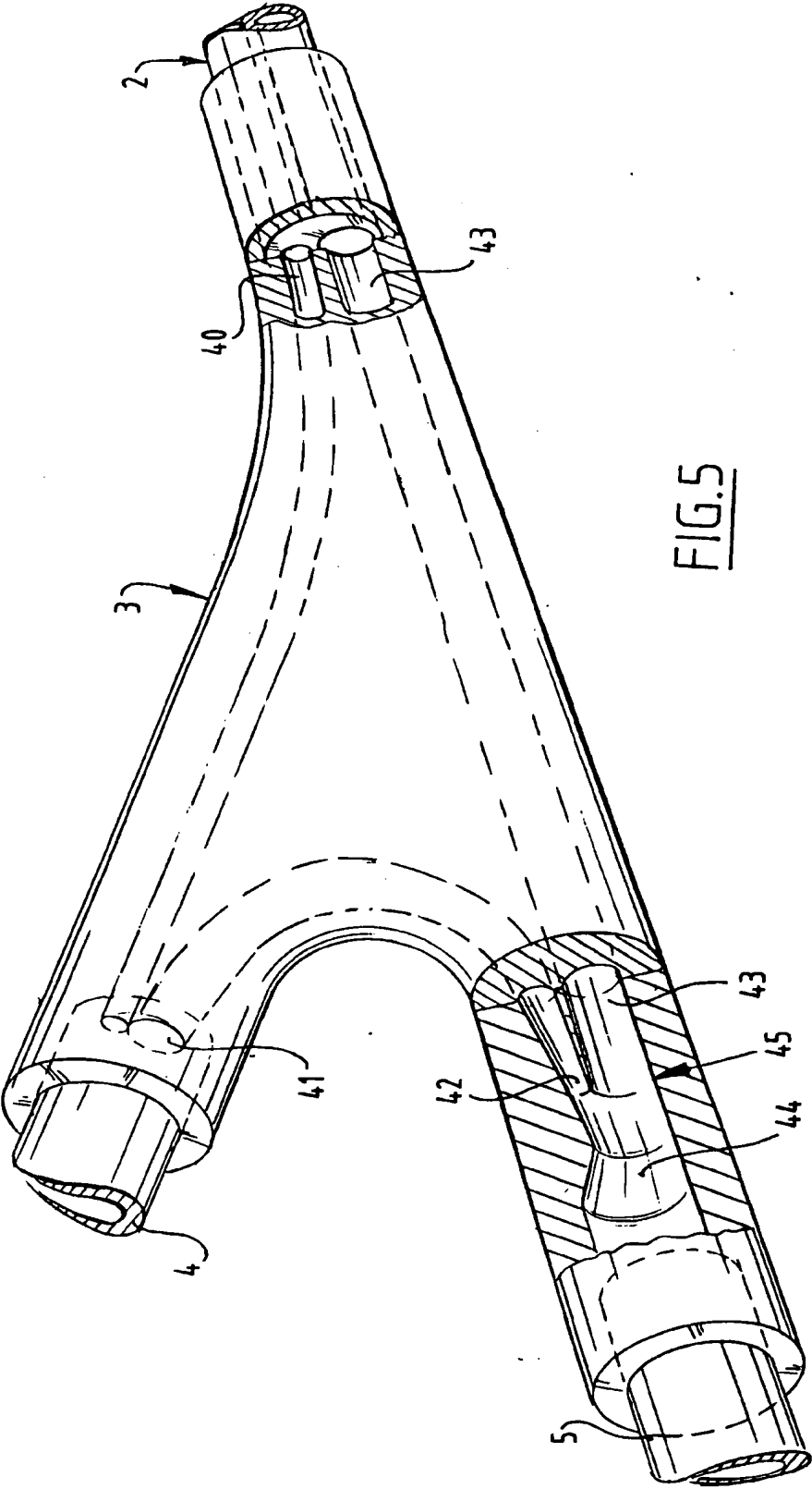


FIG. 5